Broadband matched-field source localization in the East China Sea*

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Outline

- Introduction
- Experiment description
- Environment of ocean
- Matched field processing
- Sound propagation model
- MFP source localization results
- Conclusion

Introduction

- ASIAEx2001was performed in the East China Sea.

- The environment is some complicated

- The effects of water depth mismatch on MFP source localization are investigated experimentally.

- The effects of simplified SVPs on MFP source localization are investigated also.
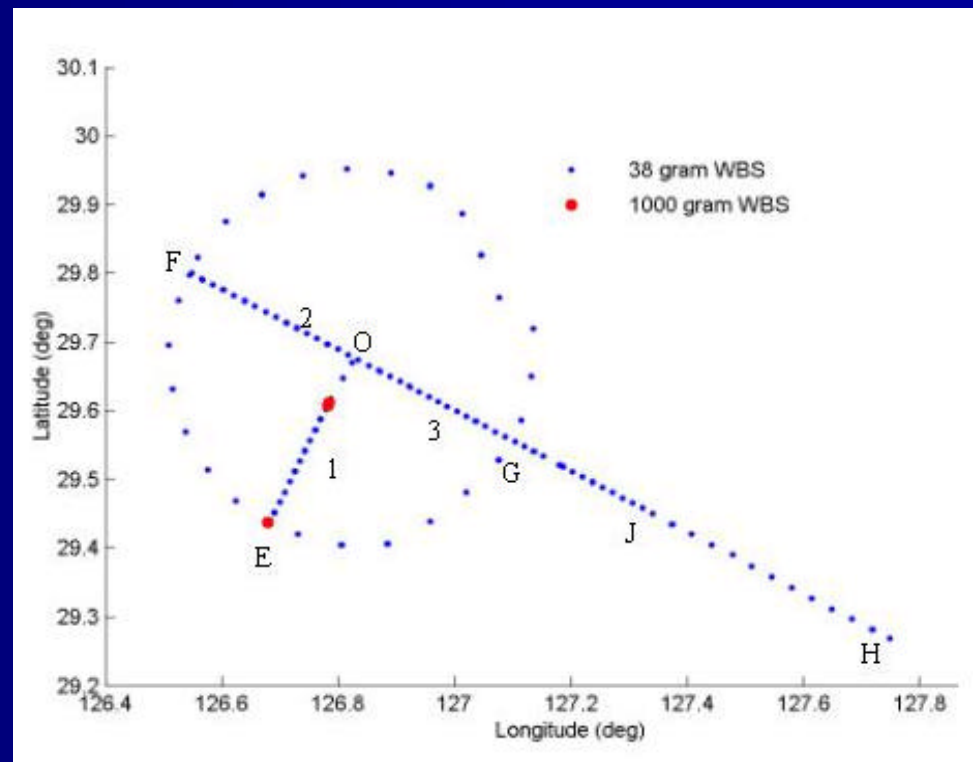
Experiment description

Shiyan3

Shiyan2

32-elements VLA

38g WBS
(50m)

The actual WBS drop locations

O: the site of Shiyan3

Direction O-E: From
center(O) to Southwest (E)
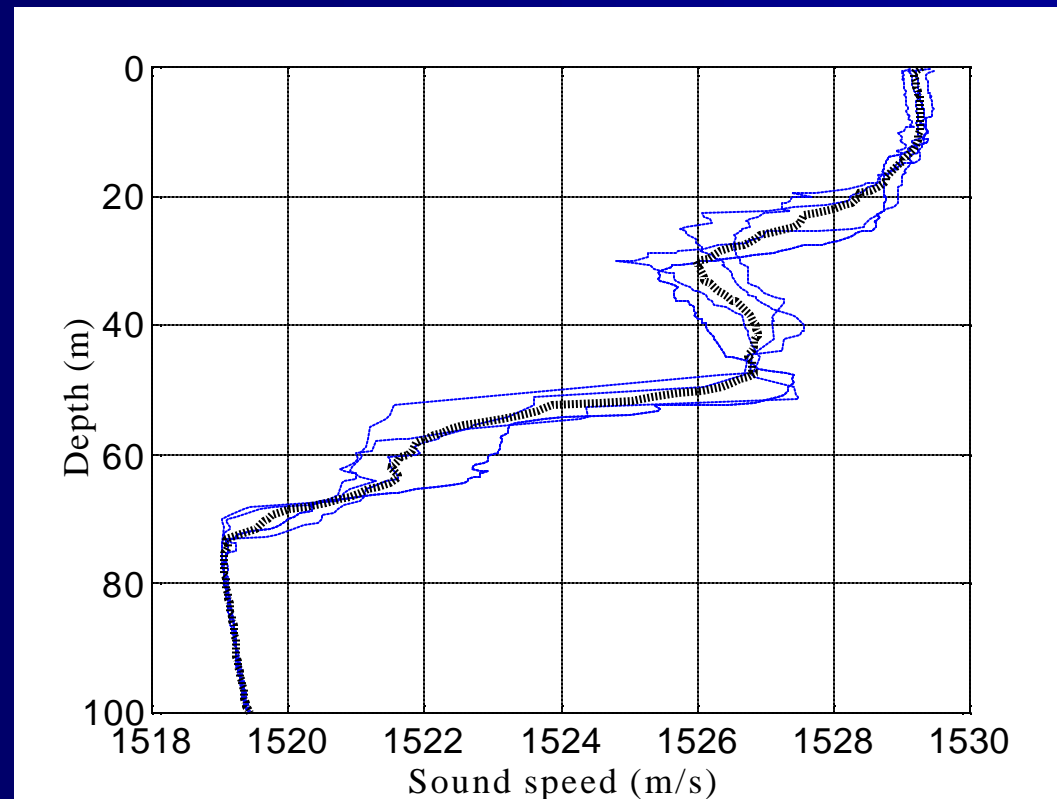
Direction F-O-G-J : From
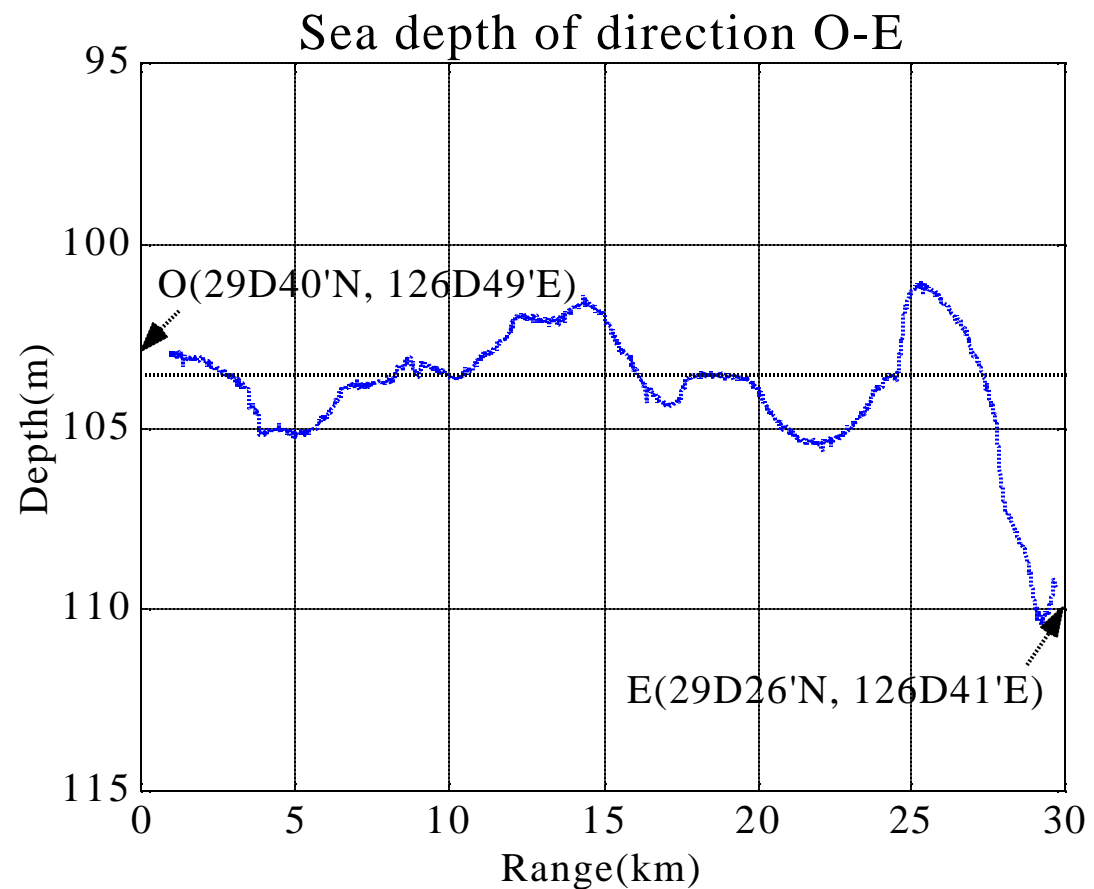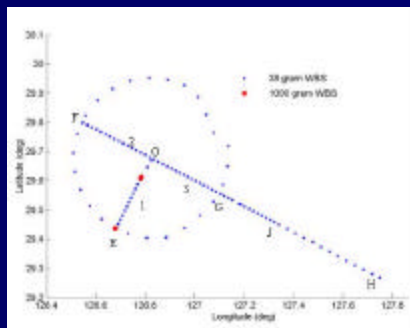Northwest to Southeast

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The Ocean Environment

- Experiment site is a continental slope environment. the sea depth vary from 96m to 150m in 80km range.

- The temperature of sea water has some fluctuation from sea surface to 70m depth.
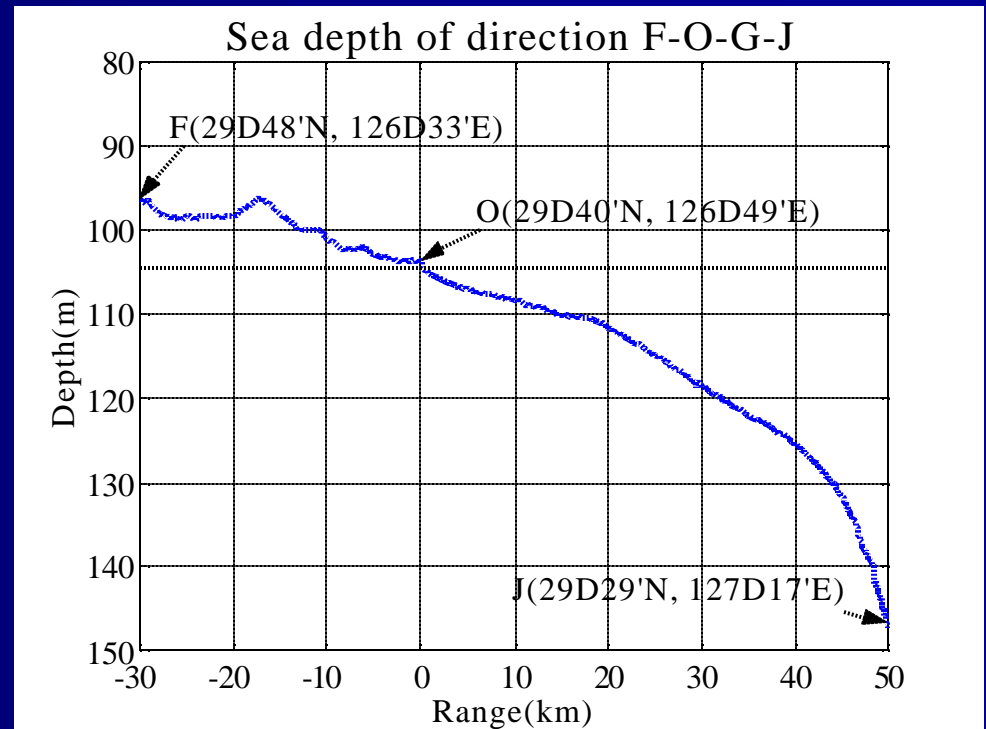
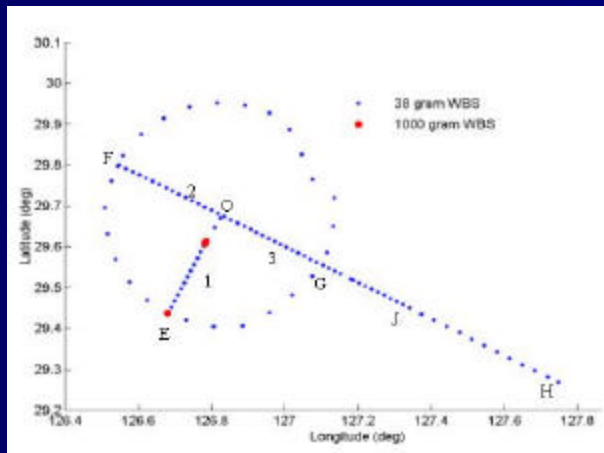# SVP of sea water used in MFP source localization

Sea-water depth from center(O) to southwest (E)

Sea depth of direction O-E

O(29D40'N, 126D49'E)

E(29D26'N, 126D41'E)

Depth(m)

Range(km)

Sea-water depth from northwest (Site F) to southeast (Site J)

Matched field processor

1 Single frequency linear Bartlett MFP

$$B_{MF}(r,z,f_j) = \frac{\left| \sum_{i=1}^{N} p_i^e(f_j)^* \, p_i^c(f_j) \right|}{\sqrt{\left[\sum_{i=1}^{N} \left| p_i^e(f_j) \right|^2 \right]\left[\sum_{i=1}^{N} \left| p_i^c(f_j) \right|^2 \right]}}$$

2 Broadband MFP

$$\overline{B}_{MF}(r,z) = \frac{1}{M_f} \sum_{j=1}^{M_f} B_{MF}(r,z,f_j)$$

Sound propagation model

- **The coupling normal mode-parabolic equation theory based on the WKBZ approximation**

$$p^c(r,z,f) = r^{-\frac{1}{2}} \sum_{n=1}^{\infty} \left[k_n(r,f) \right]^{-\frac{1}{2}} u_n(r,f) \boldsymbol{f}_n(z;r,f)$$

k_n is the eigenvalue at local range r

$\boldsymbol{f}_n(z,r,f)$ is the eigenfunction

$\left. \right\}$ **Solved by WKBZ**

u_n is the normal mode coefficient, and satisfies
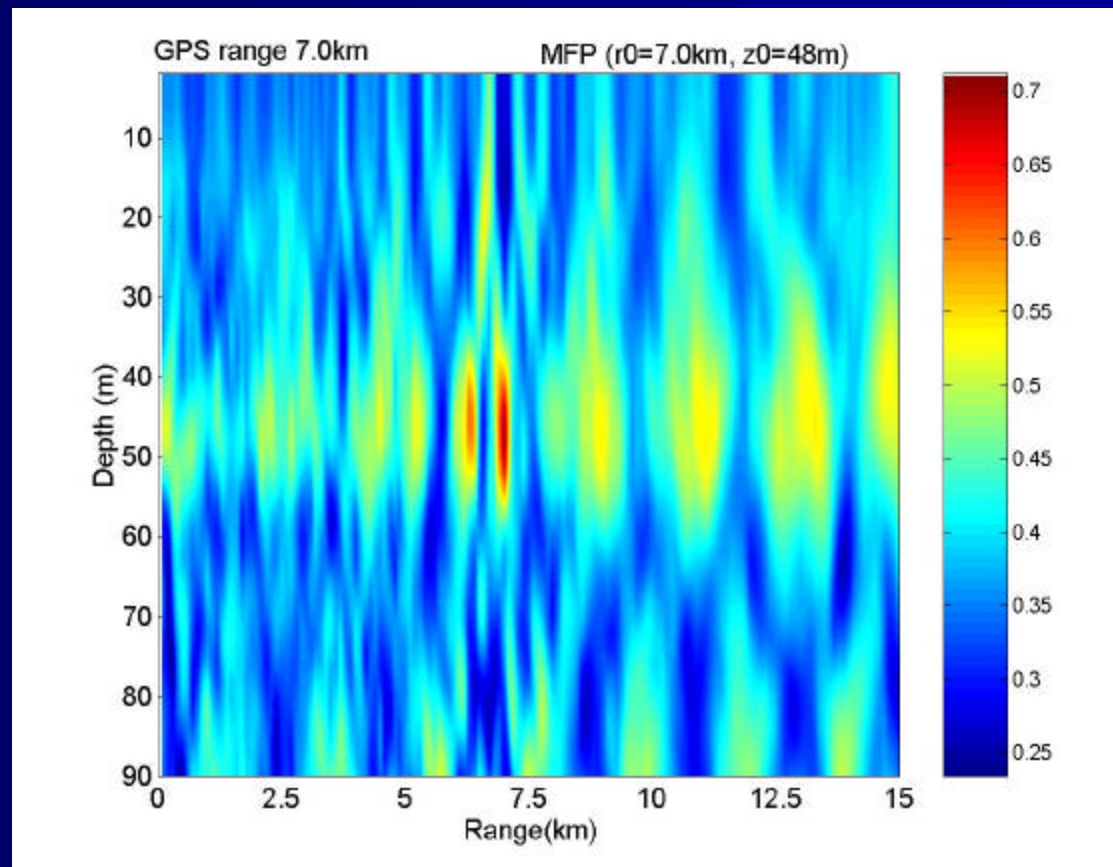
$$\frac{\partial \vec{u}}{\partial r} = -A_r \vec{u} + iK\vec{u} \leftarrow$$

solved by split step PE method

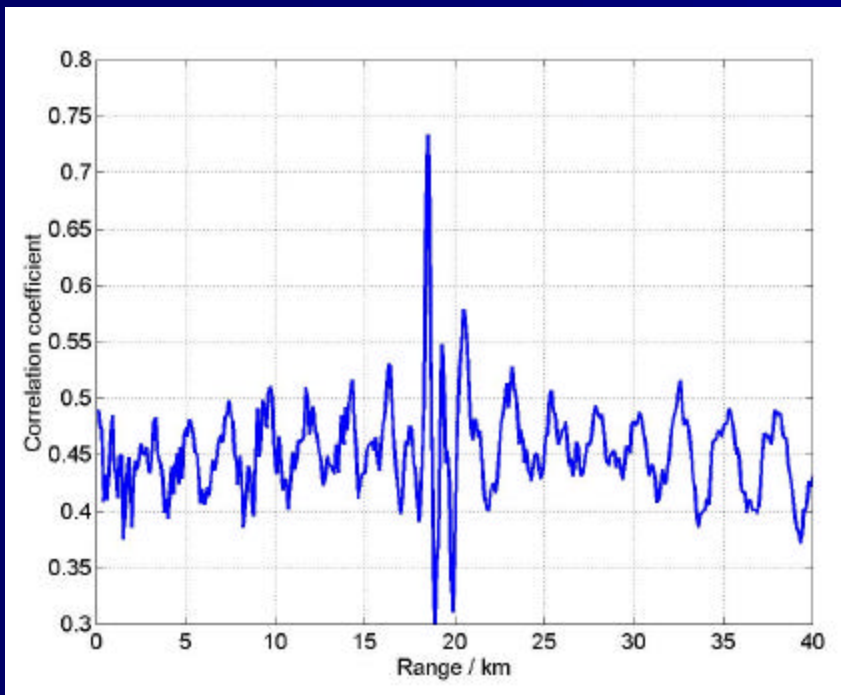# The geo-acoustic parameters of sea bottom

- Sound speed   1610.8m/s
- Density   1.86g/cm^3
- Attenuation   0.1dB/wavelength

- Replica fields calculation parameters
  - **Range step: 100m**
  - **Depth step: 2m**
  - **Frequency band : 100Hz - 200Hz.**
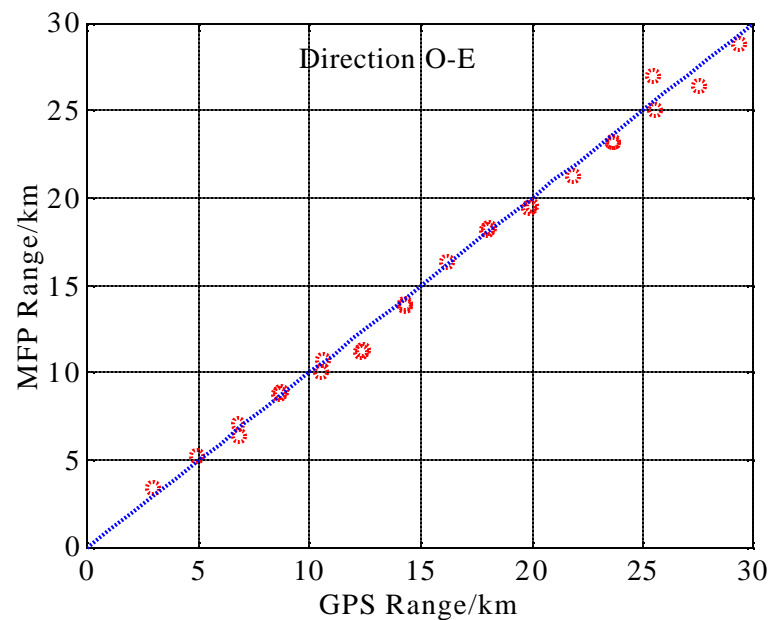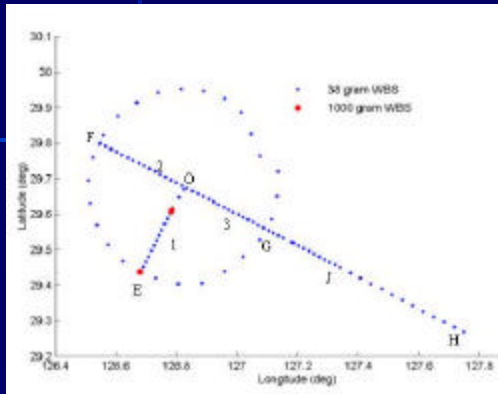
The range-depth ambiguous function of a WBS at range 7.0km

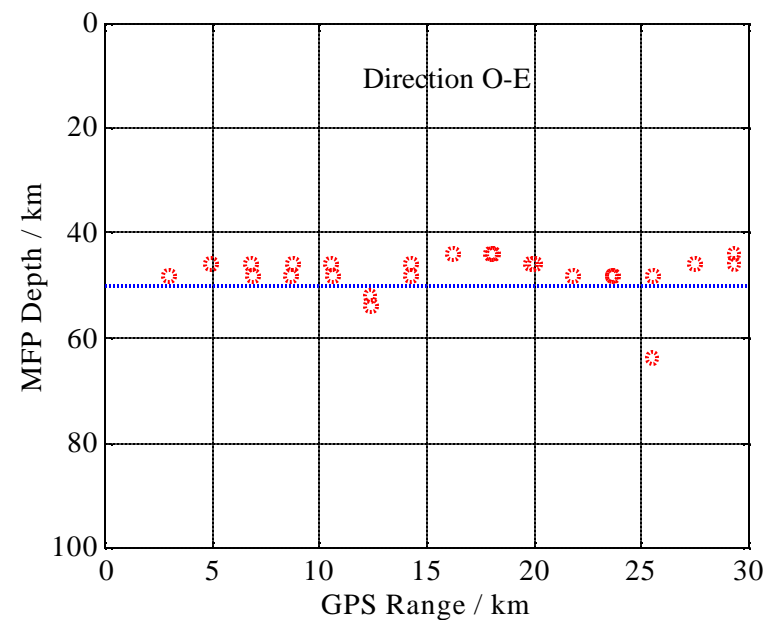# The range-depth ambiguous function of a WBS at range 18.9 km
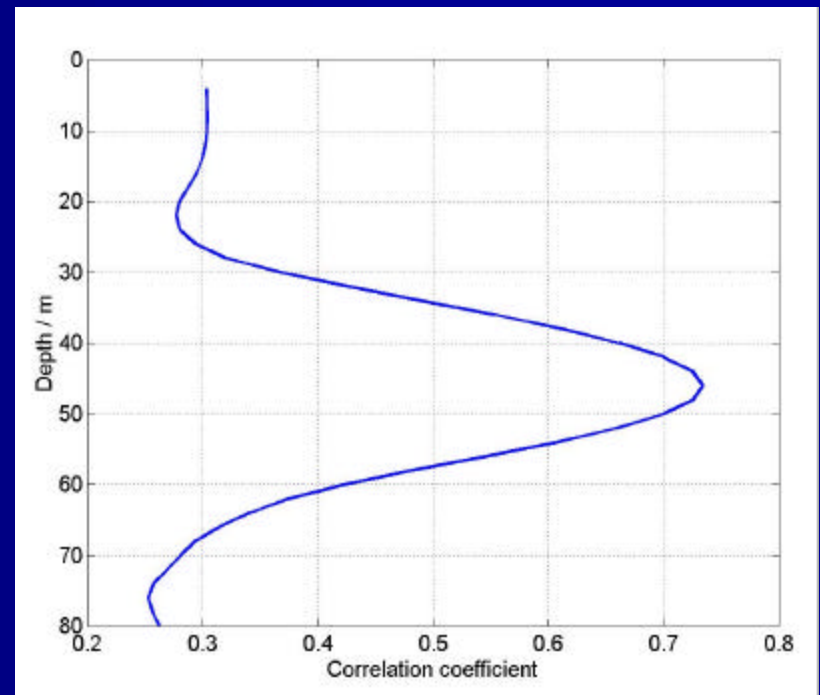
MFP range 18.5km and depth 46m

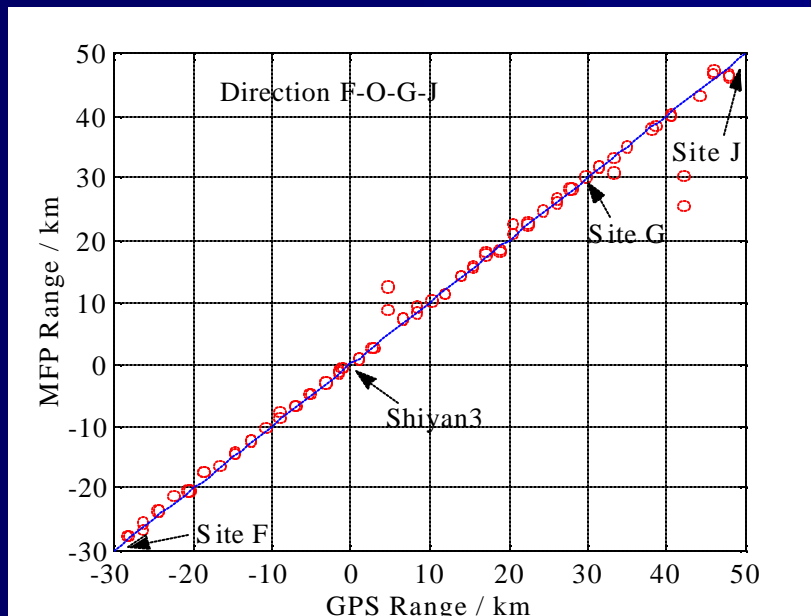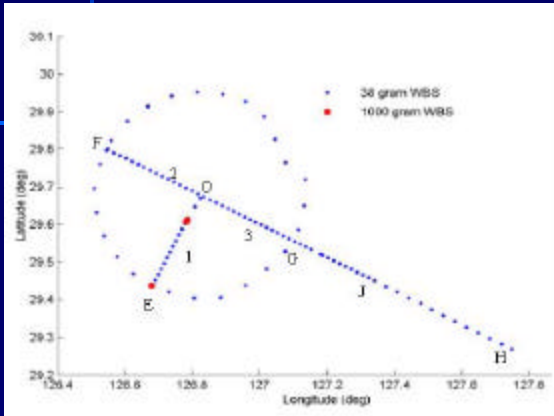# MFP results from center(Site O) to southwest(Site E) with a flat bottom
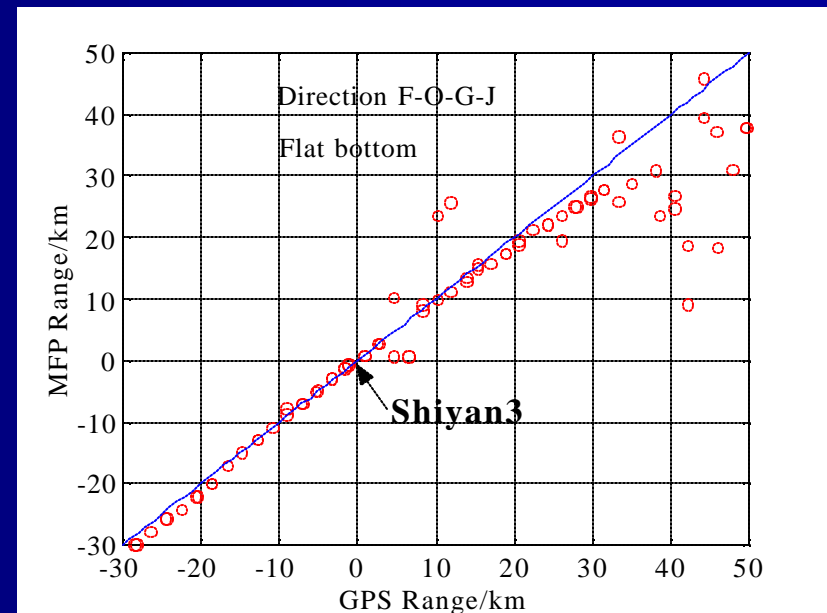

MFP range results

MFP depth results

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MFP range results from northwest(F) to southeast(J)
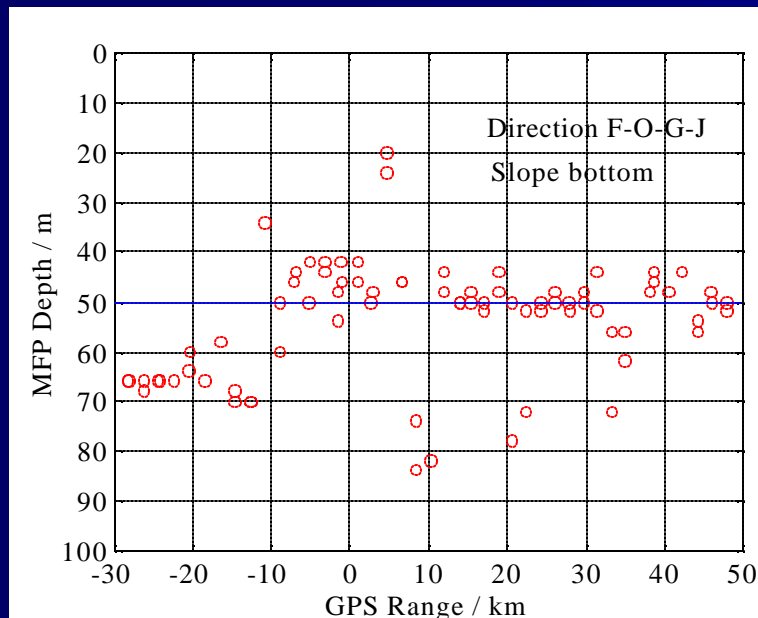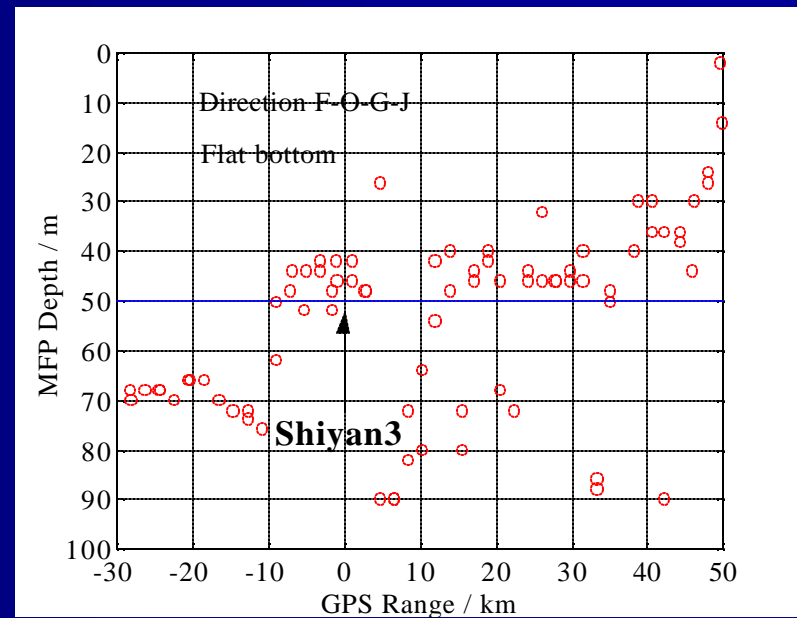

Slope bottom model

Flat bottom model

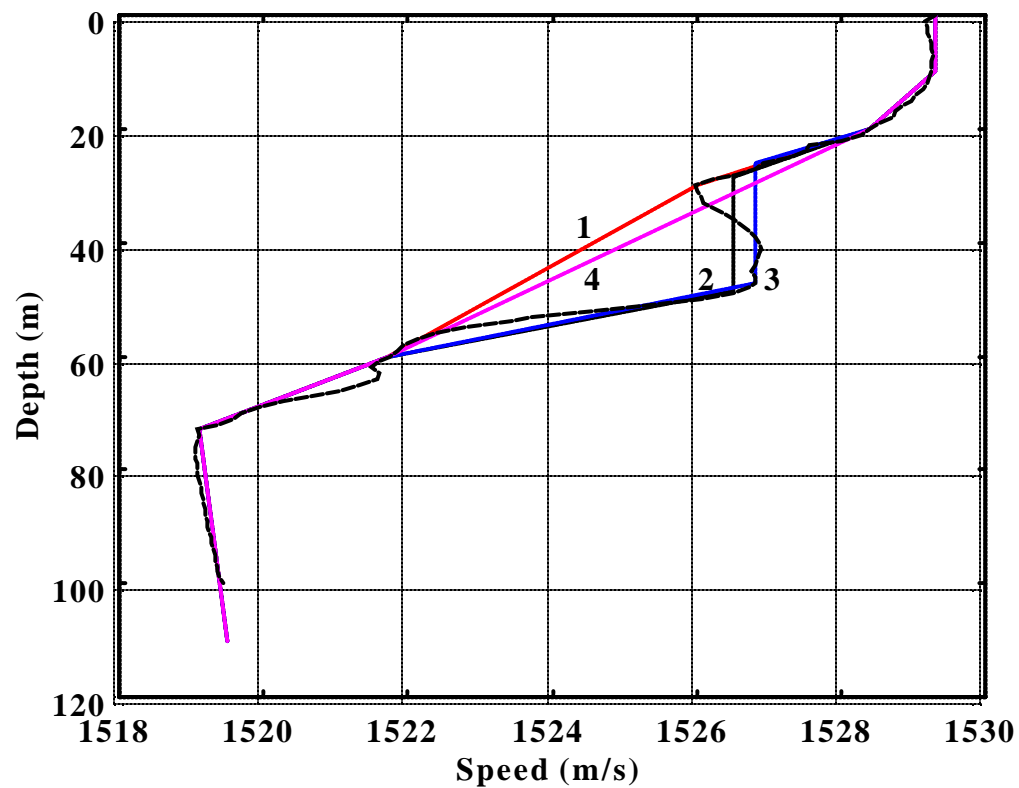# MFP depth results from northwest (Site F) to southeast(Site J)
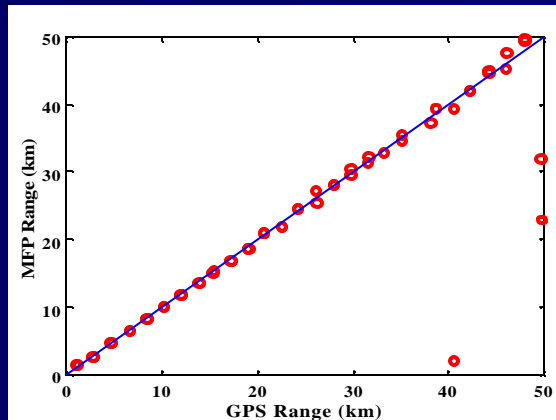

Slope bottom model   **Flat bottom model**
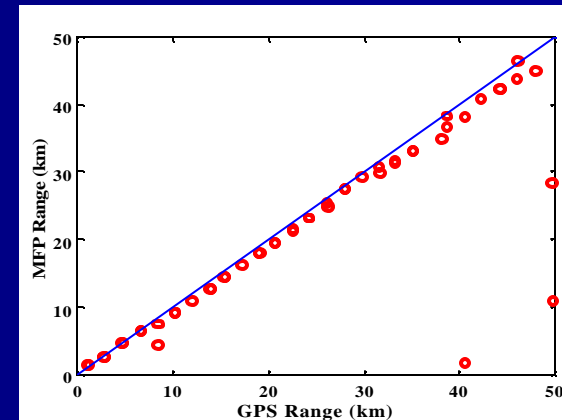
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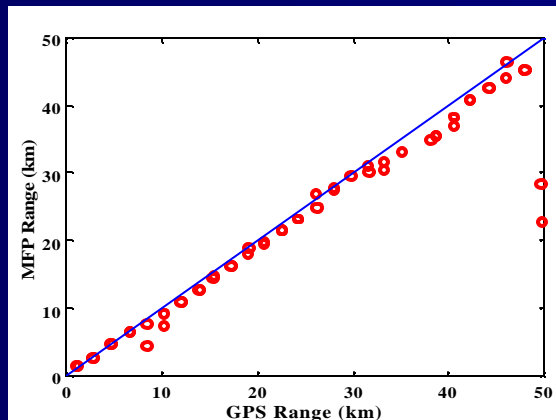# Simplification of the mean sound speed profile

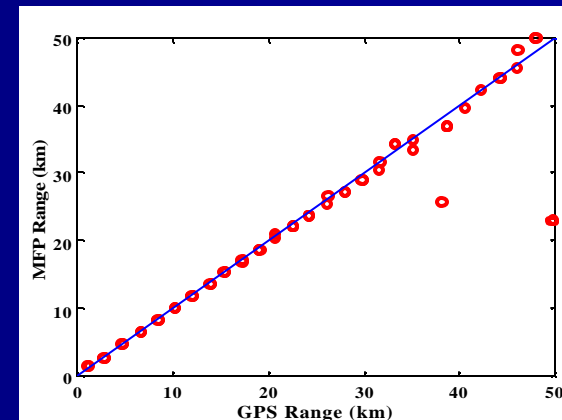# MFP range results from Site O to Site J with the simplified profiles

SVP1

SVP2

SVP3

SVP4

Summaries

- Broadband matched-field source localization is applied to the VLA signals received in the jointed ASIAEX 2001

- For the slope bottom ocean environment, if we calculate the replica fields using the flat bottom model, significant errors can be introduced into the range and depth localization predictions. If the depth mismatch is too large, it can not localize the source properly.

Summaries

- The accuracy of the source localization is largely improved with the consideration of the slope of the bottom. The range estimates of the most signals by MFP in the range from -30.0km to 50.0km are consistent with the GPS measured ones well.

- The effects of water sound speed profile on the matched field source localization are also studied in the paper. For the four types of simplifications, MFP processor could still give stable and reliable estimation of source location.

Thanks !